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ABSTRACT

Two problems must be solved before an integrated curriculum, incorporating learning with, from, and about computers can be implemented. The first is the necessity for a design of how the program will function when it has been fully implemented, with all equipment and other associated materials and procedures. The second is a strategy for proceeding to this ultimate objective, from the current unorganized activity, in an effective manner. Although much has been written about the solution to the first problem, there is an immediate need for a solution to the second, which appears to be more difficult. In designing an implementation strategy, at least eight interacting dimensions should be considered, many of which will change over time. These include the use of integrated language systems, such as LOGO or Smalltalk, and emphasis on tool uses of computers, the allocation of activities to grade levels, the allocation of activities to subject matter areas, the level of equipment availability, teacher characteristics, classroom management questions, and special student needs. Thirty-eight references are listed. (LMM)

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# INTEGRATING COMPUTERS INTO THE CURRICULUM

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Two problems must be solved before an integrated curriculum, incorporating learning with, from, and about computers can be implemented. The first is the necessity for a design of how the program will function when it has been fully implemented, with all equipment and other associated materials and procedures. The second is a strategy for proceeding to this ultimate objective, from the current unorganized activity, in an effective manner.

Although much has been written about the solution to the first problem, there is an immediate need for a solution to the second question, which appears more difficult. In designing an implementation strategy, at least eight interacting dimensions should be considered, many of which will change over time. These include the use of integrated language systems (such as LOGO, or Smalltalk), an emphasis on tool uses of computers, the allocation of activities to grade levels, the allocation of activities to subject matter areas, the level of equipment availability, teacher characteristics, classroom management questions, and special student needs.

## CURRICULUM INTEGRATION

Although at first glance it might seem obvious that the integration of computers into the curriculum is a good thing, there are substantial drawbacks which must be considered. Among these negative aspects are the increased standardization of instruction across schools, the additional overhead required in monitoring the integration, and the additional (and differential) training requirements for teachers at various grade levels and subjects.

These topics will be explored in more detail in one or more of the following sections, so they are briefly described here. If the integration of computers into the subject matter defines a specific sequence of computer material over grades and subjects, this plan will only work if it is adopted over a number of schools (at least one board), so that students may continue their computer education uninterrupted after a change of schools. This standardization may have a negative effect on local initiatives which might otherwise be found at the school level. The standardization of content also exacts a high cost in terms of the monitoring function which must accompany it, in order to determine that the chosen curriculum is indeed being followed. Finally, the integrated

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system requires differential teacher skills at different grade levels, necessitating initial teacher training, plus additional training when the curriculum is modified or teachers change grade levels. All of these factors put extra strain on the local school system, and may be sufficient to prevent school boards from adopting the integrated approach to computers in the curriculum.

What follows is a brief discussion of eight dimensions related to the integration of computers into the curriculum, including the posing of relevant questions, the presentation of selected references, and some comment on how this integration might be accomplished. Unfortunately, the following material seems to raise more questions than it answers.

## INTEGRATION THROUGH SYSTEMS

There are language systems, such as LOGO or Smalltalk, which allow exploration in one or more subject areas over a number of grade levels. What are the advantages and disadvantages of such an approach?

Overall (1981) describes how the use of LOGO at the Lamplighter School has been compatible with the school philosophy over all the grades in the school (k-4). Goles (1982, 1983) views LOGO as a system which assists in the reinforcement of positive behavior, while Abelson and Goldenberg (1977) have described the integration of LOGO into a Biology course. Going even further, Gravina (1980) has described the use of Smalltalk at a variety of grade levels, from elementary to adult.

## WORD PROCESSING, COMMUNICATIONS, MUSIC

Word processing, communications, and music are three areas of computer use which are becoming much more prominent in schools. What are important considerations in using computers in these activities? What other areas are likely to be more prominent in the next decade?

The use of word processing has expanded to include applications such as writing and studying poetry (Marcus, 1982), generating poetry (McKean, 1982), and the provision of software tools for writers (Holder, 1982). This indicates that there is sufficient depth to this application to allow effective use with most students at any grade level.

The communications applications of computers are also making their appearance in the lower grades, having had their initial impact at the adult levels, as in the communication and conferencing applications described by Hiltz and Turoff (1978). Becoming more popular in the schools are the "Bulletin Board" programs which allow students to become familiar with many of the aspects of computer communications applications. Murranka

(1982) has also described the use of electronic mail systems with business education students, preparing them for the commercial uses of electronic mail.

Music is another obvious application which extends across grade and age levels. Bergson (1982) offers one description of the use of computers in an established music program, but there are many applications in both traditional and experimental forms, with the number of applications increasing rapidly, due to the decrease in cost of computers and music synthesizers, etc.

SIMULATION AND GAMES

Simulations and games are activities which are attractive to students and have great potential for many disciplines. What must be done in order to achieve this potential without creating associated negative effects?

Often the distinction between simulations and games is not made clear. Maddison (1983) describes a simulation as the use of a dynamic model to study how a system changes. The system may be open with external intervention allowed, or closed, where the entire process is determined by the initial conditions. When the user is more than a passive observer, or there is one or more users interacting with a simulation and trying to achieve some goal, the process can be called a game. This set of definitions makes the relationship between game and simulation very close, but also more precise than the usual intuitive concepts.

One of the key factors in the use of simulations or games is the accuracy with which the given process is modelled. In particular, the person creating the simulation has to decide which are the most important aspects of the process and how they should interact. Inaccuracy of the simulation is usually less of a problem in dealing with physical processes, but can be a serious source of concern in the social sciences or humanities.

However, if accuracy (and underlying bias) problems can be resolved, simulations and games can provide useful vehicles for the integration of computers into the curriculum. Goles (1982, 1983) discusses these and other problems, criteria for the creation of simulations and games, and types of simulations, while providing examples of the various types. Malone (1981) discusses the features of games which makes them appealing to students, while also commenting on the features which makes some games more appealing to boys than to girls.

In more applications-oriented discussions, Dennis (1979), Cruickshank and Telfer (1980), and Shay (1980) provide overviews of simulation use in the classroom, with

special reference to microcomputers. One example of a simulation game which can be used over all grade levels is Rocky's Boots, a program for the Apple II which is described as being appropriate for ages 7 and up. Personal observation indicates that this is a program which can be used over this range of ages, providing a challenge to all users.

## COMPUTERS AS TOOLS

The use of computers as tools creates possible applications for most grade and subject combinations. How useful is it as a focus for the use of computers in the curriculum?

The use of computers as tools can be viewed as a generalization of the word processing application discussed earlier. Word processing is an application which can be learned quickly and easily at an early grade level and then used in many subject matter areas over the later grades. McLean (1981) has described this type of computer application as the use of "intellectual amplifiers", while Dennet (1982) uses the term "imagination extenders".

Other examples of tool use include information retrieval, described by Nerby and Hilgenfield (1981) in a junior high school setting, laboratory instrumentation, described by Cosgrove (1981), and SEMCALC, a SEMantic CALCulator used to solve word and story problems as described by Schwartz (1982).

## COMPUTERS ACROSS GRADE LEVELS

There is some dispute about the appropriate computer activities for various grade levels. How might these activities be arranged over grades so as to maximize their effectiveness?

There are a number of articles which have discussed the problem of allocating computer activities to grade levels. Hungate (1982) describes the kinds of computer activities that can be used at the kindergarten level, while Walls (1982) offers suggestions regarding the implementation of a computer literacy program for the elementary grades. Hunter (1981-82) also discusses the components of a computer literacy program for grades K-8. Murphy (1981) has extended the discussion to the implementation of computer literacy over the K-12 grade span. In more specialized discussions, Nerby and Hilgenfield (1981) have described applications appropriate to the junior high school level, particularly the use of information retrieval, while Southwell (1982) has discussed the use of computers in a developmental writing program for college freshmen, with particular emphasis on CAI.

## COMPUTERS ACROSS SUBJECT MATTER AREAS

Distributing computer activities across subject areas decreases the need for separate

classes on computers, but may lead to duplication of effort. What possible advantages and disadvantages should be considered in allocating activities to disciplines?

If computers are introduced in the form of tool applications, and this introduction takes place at the elementary level, where all instruction is likely to be done by one teacher with all students participating in every subject, the problems of allocating computer activities to subject matter areas should be minimized. The problems associated with students having multiple teachers may begin at grade seven or earlier, while student selection of subjects also starts near this level.

Possible assignment of computer activities to subject matter includes the use of word processing for language arts, instrumentation in science, graphics in art, non-numeric processing in writing including poetry, and simulations and games in many areas including history and social studies.

## LEVELS OF EQUIPMENT AVAILABILITY

What one does with no computers, or with ample computer equipment, is more clearly defined than what can be done with intermediate amounts of equipment. How can the path from famine to feast be negotiated most effectively?

The main problem seems to be that much of the creative effort has been directed toward the creation of activities for individual students, or for entire classes of students. This means that there are activities that are appropriate for using one computer in the classroom, or many computers.

One focus that might lead to more small group activities is a possible emphasis on small group work, such as team programming, or group problem solving activities. Other possibilities include the use of word processing with students being allowed access to computers over the entire day. If the computing load can be distributed, it is possible to accomodate an entire class of approximately 30 grade six students on as few as three microcomputers (with one disk and printer), although six microcomputers is more likely to be satisfactory.

## TEACHER CHARACTERISTICS

The background, training, and attitude of the teacher have great impact on which computer activities are possible. What are the necessary, desirable, and optimal teacher characteristics for implementation of computers in the curriculum?

Very little is known about the interaction of teacher characteristics and computer applications in the classroom. Bruwelheide (1982) has prepared a literature review dealing with the area of teacher competencies, but not much information is revealed.

Major concerns at present have to do with the changes which the introduction of computer technology into the classroom will bring to teacher characteristics.

The teacher's role must be considered in the context of such change. New concepts of learning, it is assumed, will require new ways of teaching and of interacting with students. The potential for increased self-teaching by students also implies an increased involvement of the teacher in the preparation and recommendation of specific materials used by the student in that process.

The teacher's role is vulnerable to modification of the structure of the classroom as well as in specific curricula. These potential changes in the teaching environment contribute to how the teacher perceives himself, how he makes professional decisions and carries out his work. Possible changes in the quality of teaching and job satisfaction are important to examine in terms of their effect on the teacher's role and self perception.

Teaching strategies include techniques and tools used in teaching as well as the selection of activities appropriate for different ways of learning. A potential change that may develop with the use of computers in the classroom involves releasing the teacher from certain kinds of activities, such as management tasks or routine lessons, thereby allowing increased interaction with students and increased time for teaching. Another important change that may occur involves the use of individualized instruction, both in drill and practise activities as well as in process learning. Teaching strategies for the use of individualized instruction are as yet unformed and need to be defined in terms of efficiency and effectiveness.

Research questions on the effects of computers on the school curriculum are considered from the point of view of the relation of curricular structure and content to teaching. The choice of curriculum materials has an important effect on teaching strategies and on interactions with students. The teacher's responsibility for that choice may become increasingly important with the introduction of computers, as teachers need to decide how to incorporate them into the classroom. Curricular issues are affected by where computers are located in the school and how they are used across grade level and subject matter. The advantages and disadvantages of different kinds of computer applications also need to be examined closely before decisions can be made about how each should be used.

Teacher's involvement in the production and selection of teacher materials is an important part of their work. How much they will and should be involved in the production of educational software is a critical part of the definition of their role as

teachers.

Finally, teacher training needs, at the pre-service and in-service levels, are a critical area of research. Classroom computer technology represents a new area of teaching expertise which will be required of most teachers. An essential part of this process involves how to introduce experienced as well as beginning teachers to this new curriculum.

## CLASSROOM MANAGEMENT PROBLEMS

One or more computers in a classroom can have major effects on classroom management. What are the best techniques to deal with various numbers of computers in the classroom?

Some of the problems associated with classroom management are closely related to the questions of teacher characteristics, but there are other concerns as well. One of these has to do with the allocation of computers and computer time within schools and classrooms (Gummersheimer, 1982), while the other has to do with support of classroom management functions which exist even without the introduction of computers (Zausmer, 1981).

Since the introduction of computers into the classroom often means that there will be more independent study by individual students or groups, the formation and use of teams for study or programming can become important. This may lead to more emphasis on teamwork in the classroom, including the use of new techniques such as those associated with the Japanese management styles (Brine, Ragsdale, & Russell, 1983).

## SPECIAL STUDENT NEEDS

Not all students react to computers in the same way. How can activities be structured to maximize the participation of all students, including those who are less likely to use computers because of one or more disabilities or preconceptions?

Most of the emphasis in this area has been in the field of special education. Sicoli (1982) reviews a number of special education applications in general, while Thorkildsen and Williams (1981) and Vanderheiden (1981) focus on the special needs of the handicapped. Di Stefano (1982) deals with the special needs and applications for the deaf, while Kolstad and Lidtke (1981) describe the possibilities available for the gifted and talented.

One special area of concern has to do with the differential use of computers by various subgroups of the school population, particularly the relative use by boys and girls. McClain (1983) raises the question of women resisting computers, while McKelvey (1983)

has studied the problem at two grade levels (grade 2 and grade 8) and presents evidence that there is a cause for concern at both grade levels.

## PLANNING THE IMPLEMENTATION

Some of the previously discussed dimensions create conflicting needs. How can a school or board integrate all these dimensions into a plan for implementing computers in the curriculum?

Although Fisher (1983) has described a district-wide plan for the implementation of computers in the curriculum and the Ontario Ministry of Education is giving strong encouragement to boards preparing their own plans, there is little available to assist boards in this type of planning. The preceding discussion has raised a number of issues, but provided few answers. Further research, particularly observation of the effects of computers on students, teachers, and other educational personnel and functions is necessary in order to provide the required information.

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